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Cankers of Apple and Pear in Oregon and Their Control

By

S. M. Zeller

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Non-profitable apple tree resulting from neglect of canker control.

CORVALLIS, OREGON

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Cankers of Apple and Pear in Oregon and Their Control

By

S. M. Zeller

INTRODUCTION

Cankers of various sorts take each year an enormous toll of fruiting wood from the apple and pear orchards of Oregon. It would be difficult to estimate the economic loss to Oregon growers from these orchard diseases, since such losses involve the cost of producing bearing trees up to 15 to 25 or more years of age. Unless they are completely eradicated cankers in an orchard are always a source of danger. Those caused by parasitic organisms are a constant source of spores from which new infections are produced; they leave openings for the entrance of wood rotting organisms, and may in time girdle and kill large branches or whole trees. It is quite often true that cankers which are not controlled by the usual spray schedule may produce enormous losses in fruiting wood before they receive the special care necessary for their control. Although cankers of one sort or another are present in every apple and pear growing district of Oregon, they are more prevalent in some sections than others.

A *canker* is a diseased or dead condition in a more or less definite area of the bark. The dead or diseased bark usually shrinks, giving a sunken appearance to the canker. This sunken appearance may be increased by the enlargement of the surrounding healthy tissues.

KINDS OF CANKERS IN OREGON ORCHARDS

There are ten different kinds of cankers on apple and pear trees which have been definitely identified in Oregon. They are:

(1) Apple-tree anthracnose or black spot canker (caused by *Neofabraea malicorticis*).
(2) Perennial canker (caused by *Gloeosporium perennans*).
(3) Frost cankers.
(4) Fire or pear blight (caused by *Bacillus amylovorus*).
(5) European canker (caused by *Nectria galligena*).
(6) Black-rot canker (caused by *Physalospora malorum*).
(7) Cytospora cankers (caused by several species of *Cytospora*).
(8) The superficial bark canker (caused by *Myxosporium corticola*).
(9) The coral-spot disease (caused by *Nectria cinnabarina*).
(10) Heart-rot canker (usually caused by *Polystictus versicolor*).

Numbers 6 to 9 are very commonly found but do little material damage in Oregon.

One other manifestation of bark injury which may infrequently be found in Oregon should be mentioned here. When trees are allowed to go without care they may become devitalized with heart-rot, until any new growth they have is very subject to winter injury. Such winter injury gives to the bark a ragged, "fluffy-ruffled" appearance because of the loose, broken epidermis and outer bark (Fig. 1).

KEY TO CANKERS

(Note: For those who are not familiar with the use of a key the following explanation may be helpful. First read the descriptions following both numbers "1." If your specimen centers around a wound, "see 3," and read all three of the descriptions under "3," eliminating two of them, etc.)

Fig. 1. A type of winter injury associated with wood decay in apple trees.

1. Cankers usually not centering on previous wound, such as broken spur, pruning cut, etc..See 2.

1. Cankers usually centering on wounds.....See 3.

2. Cankers usually on south side of trees, new bark frequently developing under the old; or, old bark dead in streaks, cracked and lifted from wood—**Frost cankers**..Page 13.

2. Cankers not confined to south side of tree; usually elliptical; bark always dead to the wood; at first smooth, dark purplish when wet, then pimply or minutely cracked with fungous pustules; annual, not enlarging after first year .....**Anthracnose,** Page 8.

3. Cankers smooth, never pimply with fungous pustules.....See 10.

3. Cankers with coral-red warts scattered over the surface .....**Coral-spot disease,** Page 20.

3. Cankers usually roughened, not exuding drops of sticky liquid or not with coral-red warts.....See 4.

4. Cankers superficial, not killing the bark to the wood.....See 5.

4. Cankers with bark dead to the wood.....See 7.

5. Cankers showing as rather smooth, irregular, firm, *very slightly* depressed areas, often reddish in color when on apple, becoming pimply with fungous pustules.....**Superficial bark canker**, Page 19.

5. Cankers at first with watery, soft, pulpy, roughened outer bark, usually in long narrow strips on branches.....See 6.

6. Affected bark dying out and no fungous bodies appearing, usually not increasing in size the second year, new bark usually forming underneath.....**Frost Canker**, Page 13.

6. Increasing in size and striking through to the wood the second year; white pustules of fungous spores appearing first spring or the next fall; tiny, round, dark-red bodies appearing second winter.....**European Canker**, Page 16.

7. Long cankers covered with pimples, which exude reddish, yellow, or cream-colored, hair-like tendrils of spores during damp weather, not enlarging year after year.....**Cytospora Canker**, Page 19.

7. Cankers enlarging year after year, not covered with pimples which exude long tendrils of spores.....See 8.

8. Cankers covered by roughened bark, or open with marginal concentric calluses, fruiting of fungus entirely superficial, either of white cushions or tiny, round, dark-red bodies.....**European Canker**, Page 16.

8. Cankers either covered or open with marginal callus, but fruiting bodies of fungus always forming tiny pimples in the skin of the bark.....See 9.

9. Cankers definite in outline, with pimple-like fruiting bodies breaking through the skin of the bark in more or less definite lines; dead bark usually falling away after the second year.....**Perennial Canker**, Page 11.

9. Cankers irregular in outline, with fruiting bodies of the fungus breaking through the skin of the bark scatteringly; old cankers roughened, dead bark usually adhering to the wood.....**Black Rot Canker**, Page 18.

10. Cankers with decayed wood beneath, which may be easily pierced with a knife blade, usually with a glassy, reddish surface, never exuding drops of sticky liquid, bark usually with a mushroom odor.....**Heart-rot Canker**, Page 21.

10. Cankers without decayed wood beneath, often exuding drops of sticky liquid, bark not with mushroom odor, eventually killing bark to the wood.....**Fire or Pear Blight**, Page 14.

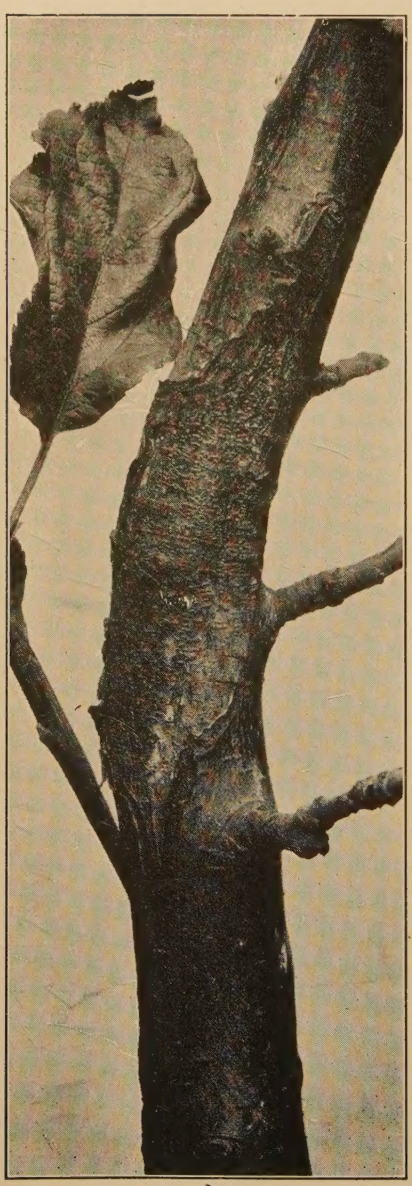

Fig. 2. Typical anthracnose canker.

APPLE-TREE ANTHRACNOSE

The apple-tree anthracnose may be identified by the cankers, which are found most abundantly on the younger branches. Large limbs and trunks are not always free from cankers, but branches having a diameter of three inches or less are as a rule the ones mostly cankered. The fungus kills the bark and cambium and slightly discolors the wood.

The new cankers begin to appear from November to January during the ordinary season. When first evident anthracnose appears as a circular spot, darkened with purplish tints when moistened. At this stage the bark is not sunken, but is discolored and has a water-soaked appearance below the surface to the wood. The canker develops very little until in March and April, when it enlarges rapidly. The spots then become elliptical, the surface sinks, and the margins develop a limiting crevice which is finally bounded by a callus.

During the late spring and in the early summer, small conical pimples appear on the cankers (Fig. 2). These break through the skin of the bark in triangular or crosswise slits and expose the creamy-white fungous bodies which discharge spores. The cankers sometimes become long and narrow, depending somewhat on the vigor of the branch affected. Large areas of bark may be killed when a number of infections become confluent. In about the third year the bark may drop away, exposing the wood. In other cases, the diseased bark

Fig. 3. Apple-tree anthracnose showing the guitar-string effect of the fibers of the bark left across the cavity beneath.

disintegrates, leaving bark fibers stretched lengthwise, like guitar strings, over a hollow (Fig. 3). Anthracnose cankers do not enlarge after the growth of the first year, and they seldom, if ever, center about any kind of wound. They are occasionally found attacking pear bark. Anthracnose also causes a fruit rot of apple.

Control of Apple-tree Anthracnose

Anthracnose canker may be prevented by one thorough summer application of bordeaux mixture 4-4-50, which can be combined with the arsenate spray for worms. Good pressure should be used to give a thorough covering both to bark and fruit. Barss and Mote* have suggested that "fruit will often require wiping after a summer bordeaux spray, and the use of a spreader makes this more difficult without materially improving anthracnose control. On dark varieties the color may be somewhat affected. In seasons of early fall rains the presence of spray on varieties like the Newtown may cause some reddish spotting around the lenticels."

Professor Barss by letter has also made the following comment concerning anthracnose control: "To avoid any possible difficulty resulting from the presence of bordeaux on the fruit, some growers are depending for anthracnose control on an early spring application of 6-6-50 bordeaux. This is either combined with the oil spray for leaf-roller used in some sections or substituted for the first or "pre-pink" lime-sulfur spray for scab. How far growers are warranted in relying solely on this spray is still somewhat an open question. That it will give a certain amount of protection has been demonstrated by Childs at the Hood River Experiment Station. If an early application of bordeaux is given, it must be put on before the fruit buds are well exposed or the fruit may be russeted. The material must be carefully pre-

*Barss, H. P., and Don C. Mote. Orchard Spray Program for Oregon. Ore. Agr. College Ext. Bul. 380, page 6. 1925.

Fig. 4. Five-year-old perennial canker which started in a pruning cut on a scaffold branch. Notice the woolly aphis where a scale of dead bark has been removed.

Fig. 5. Perennial canker on tiny twig (greatly magnified). Notice the circular waxy fruiting bodies breaking through the bark.

pared and thoroughly applied since it has to stay on the trees until fall before it becomes effective against anthracnose. Since an early spring spray can protect neither the fruit nor new shoot growth it seems unwise to place entire dependence on it unless the disease is already under good control. Where a thorough clean-up is needed, a summer spray cannot be dispensed with."

PERENNIAL CANKER

In its earlier stages the perennial canker is difficult to distinguish from anthracnose. The perennial canker is mostly confined to apple. It differs from anthracnose primarily in its perennial nature, the cankers enlarging year after year, and in the fact that it is a wound parasite, the cankers centering around such wounds as pruning cuts, anthracnose, and frost cankers or injuries due to woolly aphis, etc. (Fig. 4).

Cankers are found on small branches and twigs, and on larger branches up to six inches in diameter. They are rarely found below the main branches of a tree, except in cases of winter injury to the trunk. The earliest stages appear considerably lighter in color than those of anthracnose. On very young water sprouts or one-year-old wood, the cankers have a light tannish-brown appearance, with a glossy surface. This brownish appearance may be alternated with concentric rings of a purplish-brown color. In cankers working in older bark, the color is of a reddish-brown, or purplish tint, with rings of lighter colors appearing at the time when the tiny pimples of the fungus appear on the surface. These elevations which appear in more or less definite lines parallel with the margin of the canker, break through the skin of the bark as shown enlarged in Fig 5. As the diseased tissues become sunken, fissures are formed bounding the canker (Fig. 7). This condition is magnified by the formation of a callus by the healthy wood. Year after year the infection extends into the surrounding callus until concentric calluses form an open canker as illustrated in Fig. 6.

Control of Perennial Canker

No preventive measures of control are yet positively known for this disease. The liberal use of bordeaux mixture, however, particularly the spring application of bordeaux as used in the Hood River Valley in connection with the oil spray for leaf roller, appears to be of some assistance in checking the infections of the disease. Until the control of perennial canker is better understood one thorough application of the bordeaux 6-6-50 is suggested as an early pre-pink spray, to which may be added a good 6 to 8 percent oil spray for leaf roller. Since sprouts infested with woolly aphis die as a result of perennial canker, it has been suggested that the control of the aphis may prevent considerable spread of the disease. Exposed woolly aphis can be controlled by the application of Black Leaf 40, 1 part to 1000 parts of water, plus calcium caseinate spreader, 2 parts to 100 parts of water. This should be applied as soon as the insects begin to appear on the sprouts, usually in July.

In districts where the disease is present pruning should be reduced to a minimum or at least left until as late in the spring as possible. Existing cankers can be eradicated only by the cutting out of the diseased

Fig. 6. Notice the concentric annual growth rings in this perennial canker.

Fig. 7. Showing three-year-old and two-year-old perennial canker with the diseased bark still adhering.

tissues well back into healthy bark and painting over all cleaned-out wounds, whether cleaned canker wounds, pruning cuts or other injuries, with an antiseptic wound dressing, such as bordeaux paste made up in raw linseed-oil (see page 29).

Fig. 8. A small winter injury canker. Such dead areas often extend several feet.

FROST CANKERS OR WINTER INJURY

During severe winters low temperatures are very active in the production of canker-like areas on bark, especially on the southwest side of tree trunks and scaffold branches. This type of injury is often known as winter *sun scald* because it is supposed that the injury confined to the southwest side of the tree is due to the action of the sun in warming the tissues before a severe cold period. Although this is the usual type of winter injury there are other types, the chief of which is known as crotch injury.

Fig. 9. Winter injury frequently occurs around wounds.

Freezing injury is identified in the spring by the dead bark which usually has a sour odor and may crack and peel, exposing a discolored cambium and sap-wood (black in the case of pear tissues); or the bark may adhere, shrink as it dries out, forming a sunken area (Fig. 8). In

other cases a new bark is developed beneath the old, which scales off. Sometimes the wood is killed but the cambium and inner bark remain alive. In such cases, a new sap-wood cylinder is grown, covering a dead black or dark brown heart. Winter injury cankers are commonly inhabited by saprophytic and weakly parasitic fungi, such as those causing perennial, European, black rot, Cytospora, and superficial canker, as well as by wood-rotting fungi. For this reason, all such cankered areas should be thoroughly cleansed of all dead, loose, or ragged tissues and coated with a wound dressing (see pages 26-29).

Control of Winter Injury

The control of winter injury consists chiefly in such orchard practices which will throw the trees into dormancy early in the fall. In clean-cultivated orchards thorough cultivation early in the season is advised, but the operation should cease early enough to allow the trees to harden. A cover crop planted in August will do much to take care of the excess moisture in the fall. In irrigated districts no water should be used late enough to hinder early maturity. Susceptible trunks and branches may be helped by painting with whitewash in the fall or early winter.

PEAR OR FIRE BLIGHT CANKER

Fire blight of pear and apple trees is caused by a bacterial organism. The blight bacteria gain entrance to the tree in several ways, such as (a) through bites of insects; (b) through the open flowers, to which they are carried by insects, such as bees and ants, and by wind; and (c) through mechanical injuries such as pruning cuts. When the organism gains entrance to the bark it multiplies rapidly and works downward and upward.

The bark of the affected branches or trunk becomes slightly darkened in the apple and almost black in the pear. The limits of the diseased and healthy bark are often not distinct during the growing season, so that the disease has frequently progressed farther than an inexperienced grower would suppose. In the active season, vigorously growing cankers may exude droplets of a sticky liquid from the breathing pores in the bark, as illustrated in Fig. 10. When the activity of the organism ceases the diseased tissues dry and shrink, leaving very prominent, irregular, torn crevices in the bark so that the limits of the canker are very definite. The surface of the canker remains relatively smooth, the bark clinging tightly to the wood (Fig. 11). Among the most difficult blight cankers to deal with are those which occur at the base of the trunk and on the roots below ground.

Control of Blight

The only method that has been at all successful in the control of blight is the cutting out of all the diseased parts, burning them and disinfecting the wounds. If this work is done promptly and thoroughly the disease may be held to a minimum, but the method does not always prevent the recurrence the following year.

The removal of affected parts should begin as soon as the disease appears in the orchard, and the grower should be vigilant, patrolling the orchard frequently throughout the growing season, cutting out infected branches and twigs as rapidly as they appear. In the fall or winter a very careful survey of the orchard should be made and all traces of diseased bark and wood removed from branches, trunk, and roots. This is most important and is done to eliminate the "hold over" sources of infection for the trees the next spring.

Fig. 10. Fire blight on pear twig showing the drops of ooze from the new canker.

When cuts are made, all of the diseased tissues must be removed. When carefully scrutinized there is usually visible late in the season a rather distinct line between the diseased and healthy parts. The cuts should be made well on the healthy side of the line to insure success.

One precaution very necessary to success is the disinfection of tools and of all wounds. *After each cut* the pruning shears, knife, saw or any other *tool* used in working in wood or bark that might harbor blight, *should be disinfected.* This is accomplished by dipping the tool in a disinfecting solution made up in the proportions of 1 part of mercuric cyanide and 1 part of mercuric chloride in 500 parts of water by weight. This solution, which can usually be made up by a druggist, should be carried in a glass,

Fig. 11. Fire blight canker on apple stem.

wooden, or earthen vessel, and not in a metallic one. Wounds also should be treated with this solution and, unless in a very dry climate, the wounds should have a subsequent coat of tree paint.

It should be stated here that Reimer* has made recommendations for resistant rootstocks and trunk and framework stocks for pears. Those who contemplate planting pears should obtain his bulletin from the Oregon Agricultural College.

Fig. 12. Open type of European canker in the crotch of apple branch. Notice that this is several years old.

There exists a possibility that some satisfactory repellant and disinfecting spray may yet be devised which will reduce somewhat the frequency of infection and supplement the surgical methods to which reference has been made. Experiments begun in southern Oregon give some promise in this direction.

EUROPEAN CANKER

Like the perennial canker, the European canker of apple and pear trees starts at some wound and enlarges year after year. Winter-injured bark is extremely susceptible to infection unless coated with a fungicide. On apple trees in Oregon this canker is produced in the open and closed types, while on pear trees it also appears principally in two forms; i. e., closed and superficial cankers. The open canker is best understood by reference to Fig. 12, which illustrates the series of concentric calluses, one of which grows in the healthy tissue at the extreme margin of the canker each year. The next year the new callus of the previous year is invaded and killed by the fungus. This type is distinguished from the perennial canker, older specimens of which it markedly resembles in gross outline, chiefly in the last year's growth or outer ring of the cank-

*Reimer, F. C. Blight resistance in pears and characteristics of pear species and stock. Ore. Agr. Exper. Sta. Bul. 214. *Figs. 1-35.* 1925. (See pp. 97-98.)

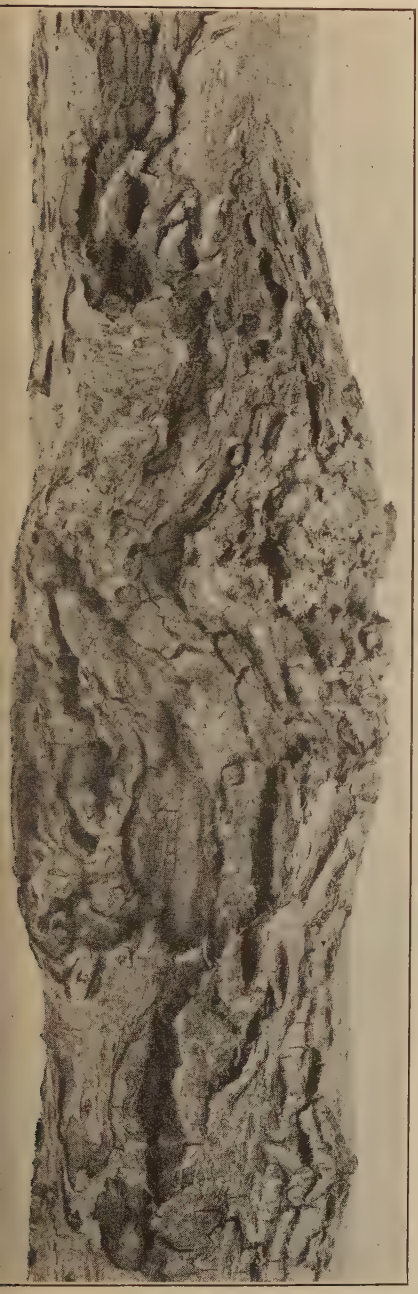

Fig. 13. European canker of apple branch, covered with dead bark.

er. In this marginal ring in perennial canker the bark is rather smooth except for cone-shaped pimples of the fungus breaking the diseased bark, while in European canker this portion is usually irregular, and roughened by cracks in the bark. The closed type of European canker of apple is illustrated in Fig. 13 and that of the pear in Fig. 14. The superficial type of European canker found on pear does not kill the bark to the wood the first year, but may the second year, after which it develops and appears like the closed canker. The white pustules of fungous spores appear on the cankers either the first spring or the next fall and winter (Fig. 14). A second type of fungous fruiting appears as tiny, round, dark red bodies which discharge spores during the second winter and spring (Fig. 15).

Control of European Canker

Since the causal fungus is perennial, it is necessary to cut out all open and closed cankers and to shave or scrape off all superficial cankers with a sharp tool like a farrier's knife. This cutting away of the surface in the latter case should extend well beyond the visible limits of the canker so as to uncover all dark streaks in the pulpy portion of the bark above and below the canker. All diseased bark and any healthy bark covering discolored cambium should be cut away from cankers extending to the wood. All wounds should be treated with a tree paint, such as bordeaux paint, made up as explained on page 29.

The number of new infections will be materially reduced by an application of bordeaux mixture 4-4-50 before fall rains begin. Where the summer bordeaux is applied for the control of anthracnose, additional applications should be unnecessary.

BLACK ROT CANKER

In Oregon, this canker has infrequently been found in the Hood River, Willamette, and Umpqua valleys. It seldom attacks pear trees. The black rot canker assumes its worst form when its infection follows attacks by other fungi, winter injury, sunscald, or die-back from various causes. Of itself the black rot fungus under Oregon climatic conditions, seems to cause merely superficial cortex cankers, and these always originate in some sort of wound.

The canker usually forms on larger limbs, although smaller branches and the trunk may be affected. At first, the bark

Fig. 14. Superficial type of European canker on pear. Notice the white pustules of fungous spores.

Fig. 15. These are the dark red, rounded fruiting bodies of the fungus causing European canker. They are usually more scattering than shown here.

is of a reddish brown color and slightly sunken. Many times the cankers remain superficial and die out at the end of the season, but in severe cases the cankers enlarge year after year. In Oregon the canker does not assume large proportions in well sprayed orchards. It usually appears as shown in Fig. 16. The progress of the fungus is marked by the series of irregularly placed, curved, eccentric cracks in the bark. The

bark usually remains closely applied to the wood, but may fall away after the second or third year. The fungus produces spores from tiny, pimple-like elevations which break through the skin of the bark (Fig. 17). These elevations are promiscuously scattered over the surface of the dead bark. In orchards which are neglected the black rot of apple fruit and the leaf spot may infrequently be found.

Fig. 16. Black rot canker following winter injury on an apple branch.

CYTOSPORA CANKER

Following winter injury, Cytospora canker has been found prevalent in Western Oregon. The canker appears on twigs, branches, or trunks of young and old apple and pear trees. Entrance is gained through wounds, usually sunburned bark, winter injury, or devitalized branches. Trees grown on shallow soil which does not have the best of drainage are susceptible to this disease. The affected tissues of the bark are darkened and water-soaked, while the reddish colored skin cracks and easily slips off. Later the pimply fruiting bodies cover the long narrow cankers, and under moist conditions, amber, yellow or creamy tendrils of spores ooze from their craters (Fig. 18). Although the canker is limited almost entirely to devitalized trees or parts of trees, it is not a disease which should be allowed to run uncontrolled, for when access is once gained, the fungus does destroy many trees which under adequate care could be brought back to proper vigor.

SUPERFICIAL BARK CANKER

This canker is not infrequently found affecting pear and apple bark in Oregon orchards. Its damage to the affected tree, if any, is very slight although its presence may perplex some growers. It is most easily described by reference to the illustrations (Figs. 19 and 20). The affected bark is slightly sunken and browned to a very short distance under the skin, but not to the wood. The margins of the cankers are irregular and quite indefinite. For the most part, the surface is quite smooth, with a tendency to crack in rectangles in cases of the canker on pear. The tiny fruit bodies breaking

through the skin are irregularly scattered over the surface of the affected bark. They exude creamy white, globular masses of spores.

CORAL-SPOT DISEASE

This disease may be found as cankered spots usually following winter injury or more commonly as an infestation on die-back branches. These may invade the parent branch. It is found affecting pear more commonly than apple bark. It is never a serious disease on either tree except that it may do considerable damage following winter injury in the same manner as *Cytospora*. The first stage of the disease takes the form of smooth, globular, coral-red warts thickly scattered over the surface of the affected bark (Fig. 21a). These bright colored warts are very conspicuous and are sufficient to identify the disease. At a later stage, the warts turn rusty brown and become rough, with projecting rounded bodies (Fig. 21b). The affected branches should be removed, since the warty spots are the fruiting bodies which liberate the spores of the fungus causing the disease.

Fig. 17. Black rot canker from an artificial inoculation on apple bark. Notice the tiny fungous fruiting bodies.

CONTROL OF BLACK ROT, CYTOSPORA, CORAL-SPOT AND SUPERFICIAL BARK CANKERS

These cankers are relatively of little importance in Oregon, but their control should be mentioned here for the sake of those growers who have occasional trees affected. Undoubtedly the spray program usually prescribed for the control of other fungous diseases does most to keep these diseases in check.

The chief means of control of these diseases is the complete removal of cankers or cankered branches from the trees (see page 25). It is doubtful whether it would be worth while to pay any attention at all to Superficial Bark canker.

HEART-ROT CANKER

Heart-rot cankers result from the fungus in rotted heart wood growing out through the sap-wood to the bark. Usually the bark is well rotted and when peeled away gives a rather distinct "mushroom" odor. These cankered spots usually become glossy, reddened patches, through which a knife may be easily pushed to the decayed heart. Heart-rot cankers may occur around the pruning cuts, or other wounds, which

Fig. 18. Cytospora apple canker showing the tendrils of fungous spores coming out of the fruiting bodies.

Fig. 19. Superficial bark canker on apple. Notice the slight depressions and the tiny white fungous fruiting bodies.

were the courts of entrance of the fungus causing the trouble, or they may break out at any place where the decay comes out to the bark. Fig. 22 shows such a canker around a pruning cut which was made so as to leave a stub of dead wood. Such stubs cannot heal and are sources of heart-rot infection. Fig. 23 shows the interior of the same branch as illustrated in Fig. 22. All of that portion inside of the dark lines in the wood is thoroughly decayed, and around the pruning cut the decay has penetrated to the bark, producing the canker.

Fig. 20. Superficial bark canker on pear.

A very significant fact is illustrated in Fig. 23, which is a photograph of a specimen of apple wood received from a semi-arid district of Eastern Oregon. This is the manner in which the heart-rot has advanced into branches as small as one-half inch in diameter. In Eastern Oregon, conditions favorable to wood decay are consistently fulfilled. After the fungus has entered the wood the necessary condition for advance of wood decay is just enough water in the wood to support growth but not enough to crowd out the air necessary for the fungus. The low humidity of the atmosphere is conducive to heart-rot because the wood of the trees is dried out enough to allow the entrance of air. In Western Oregon when a tree passes into a dormant condition its wood is in a fit condition for the rapid progress of decay if the fungus has once gained an entrance. Most orchard trees have been forced to grow rapidly. The wood of such trees is light and porous, and it has been demonstrated that such wood decays much more readily than heavy, slow-growing wood.

Since wood decay is caused by fungi which gain entrance through wounds, the control of heart-rot and heart-rot cankers consists of the proper protection of wounds. It is of course best to adopt a pruning system such that the necessity of large pruning cuts is reduced to a minimum. In Eastern Oregon especial care should be given to pruning properly so that the cuts are easily healed in the shortest possible time.

TREATMENT OF WOUNDS

Large wounds must be properly and adequately treated to prevent heart-rot. Orchardists often ask whether all wounds should always be covered with a dressing. In order to answer this question intelligently

Fig. 21. The coral-spot disease. "A" shows the coral-spots near a pruning cut; "B" shows the rusty brown fungous fruiting bodies which appear the next year after the coral-spot.

the writer made a survey of many well-kept, consistently sprayed apple orchards of Western Oregon. This survey has revealed a surprisingly low percentage, less than 1 percent, of wounds infected with heart-rot. In pears such wounds are practically no more frequent; i.e., 1¼ percent

infection. In abandoned apple orchards, however, heart-rot which apparently had entered through pruning cuts was found to run as high as 11½ percent. Therefore in apple orchards of Western Oregon where bordeaux sprays for the control of anthracnose and other fungous diseases have been applied consistently, heart-rots are not a menacing factor, unless some special condition (such as severe winter injury) has arisen necessitating very large wounds or pruning cuts. The usual spray program in pear orchards seems to be sufficient to wash the ordinary pruning cuts for the prevention of infection by wood-decaying organisms. No chances should be taken with any wounds of considerable size, however, for the time necessary to bring about complete healing also allows too great chance for heart-rot infection. The writer cannot say that smaller cuts will not be infected to some extent in well-sprayed orchards, especially under the semi-arid climatic conditions of Eastern Oregon, but the orchardist should certainly treat all apple and pear wounds two inches in diameter or more with a fungicidal wound dressing. This should be done as soon as practicable after canker wounds

Fig. 22. Heart-rot canker near a poorly executed pruning cut. Such pruning cuts never heal and are always a court for infection by wood-rotting fungi.

Fig. 23. The interior of the same pruning cut and heart-rot as illustrated in Fig. 22. Notice that all of the wood within the dark line is thoroughly rotted leaving a very small proportion of wood for the conduction of sap.

are cleaned out or pruning is done. If the weather is relatively dry when the wounds are fresh two or three days may not be too long to wait, but under damp conditions spores on the surface of wood will germinate in a few hours. Then, too, in an extremely short time spores may be drawn so far into the wood with rain water that the fungicide will not effectively reach them.

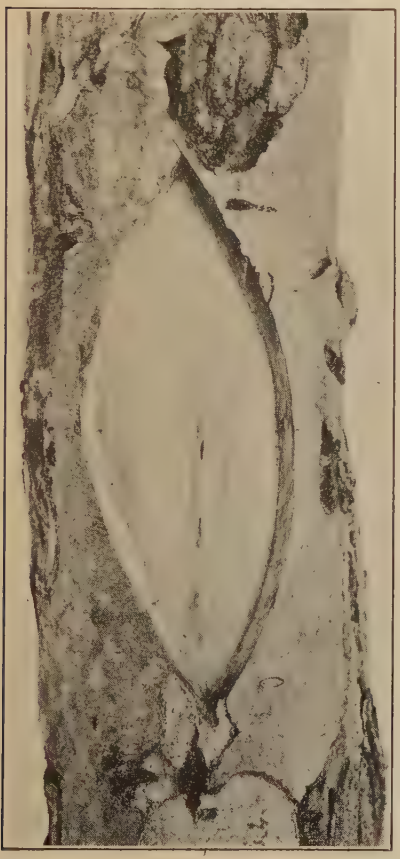

Fig. 24. Proper shape to leave wound resulting from the removal of a canker. Notice the pointed ends of the wound and the perpendicular cut of the bark.

There is a correct way as well as a wrong way to prepare wounds for successful and rapid healing.

The cutting out of cankers should be employed only when the grower is sure that the value of the branch warrants it. Tools must be sharp. A knife such as that used for budding is useful in cutting along the margins of cankers. For cleaning out crotches and crevices a farrier's knife is useful, while a drawshave may be used for scarifying larger surfaces. When all of the diseased tissue is removed, the canker wound should be shaped up so as to be pointed above and below, since this facilitates healing (Figs. 24 to 26). The edges of the wound should be cut at right angles to the bark surface, for slashing cuts do not readily heal.

Pruning cuts. When it is necessary to remove a whole cankered branch, care should be taken to make the cut as near the parent branch as possible. This aids early healing. Stubs of branches can never heal (Fig. 27); they die and become infection courts for wood-decaying fungi (Fig. 22).

If orchard practice has been such that cavities and decayed hearts are present, a few simple methods of tree surgery now may obviate the need of much greater use of time and money later. The heart of a tree is dead wood and is of no importance to the tree except for strength. Its removal, if decayed, will therefore not be a detriment; it may be beneficial and worth while in cases where the time and labor involved are not too great. A mallet, chisel, and gouge are the essential tools. If the cavity extends down the branch for a considerable dis-

tance, it should be provided with a hole as a drain at its lower end, or if the cavity is cup-shaped the lower edge of the cup should be cut away to allow drainage.

WOUND DRESSINGS

The sole object of painting a tree wound is to prevent the wood from infection by decay-producing organisms until the wound is healed

Fig. 25. Canker wound which healed in three years after treatment as illustrated in Figs. 23 and 24.

by callus formation. Wound dressings do not induce more rapid callus formation, but the protection they give allows the growth of healthy tissue over the wound.

There are many antiseptics for tree wounds which have been recommended by different experimenters and applied with various degrees of satisfaction. These wound coverings are either "air tight" or "air porous." Asphalts, lead paints, and grafting waxes are sometimes used as "air tight" coverings, while some coal tar products and bordeaux paste or bordeaux paint are examples of "air porous" coverings. There have been some objections to both kinds of dressings. The chief objection to the "air tight" coverings is that the sap pressure back of such a coating will rupture it and there will be enough of the sap retained behind

the coat to keep the wood moist and thus to insure rather than prevent infection by wood-rotting fungi. For this reason the plant pathologists at the Oregon Experiment Station have for some time recommended the use of an "air porous" wound antiseptic since the trees under Western Oregon conditions usually are relatively sappy during the winter months.

Fig. 26. A poorly shaped wound. Notice that the ends have very little callus. Such wounds heal very slowly, affording a ready entrance for wood-decaying fungi if untreated.

For this dressing bordeaux paste made up with water has been used with success, except that it is not durable and the orchardist cannot afford to repeat the wound dressing each season.

During the last few years, therefore, the writer has experimented with many different wound dressings. Among these the one which comes nearest to combining the necessary properties for a successful

tree paint is *bordeaux paint.* This is a wound coating which will remain permanently over a period of at least 4 years. According to the writer's

Fig. 27. Pruning cut improperly made. The cut is diagonal so that the right side, which is even with the parent branch, is healing well, while the left side, which is long and stub-like, cannot heal. The bark was also stripped off below so that healing there is very slow.

experience it does not injure the bark, makes a close union with the wood, is not hard or thick enough to prevent free callus formation, and is easily applied. If made up properly it forms a skin-like coating as does a lead-paint, although sufficiently "air-porous" so that pockets are not formed behind it.

Some workers have stated that they have had slight injury to the margins of wounds by using any preparation containing copper. To obviate such injury Volck* advises first treating the cut edge of the bark with a ring of a grafting wax, made up of a mixture of asphaltum and paraffin, before applying bordeaux paste to the wood. In Southern California it has been found that although the callus formation is more rapid under such air tight coatings as grafting wax than when bordeaux

Fig. 28. These fungous brackets are an indication that the wood decay within has progressed beyond redemption.

paste is used, this slight disadvantage with the bordeaux is many times compensated by its prevention of heart-rot. Some types of coal tar may be used without injury, as Mr. Leroy Childs of the Hood River Experiment Station has recently demonstrated.

Bordeaux paint is prepared by stirring raw linseed-oil *into* one of the commercially prepared bordeaux dusts. The writer has had success with the Sherwin-Williams Fungi-Bordo. A quantity of the dust, sufficient for the treating project at hand or convenient for a day's operations, is placed in a pail. While stirring, raw linseed-oil is *slowly* added until a thick smooth paint is formed. It is desirable that the paint be thick when prepared, for it apparently becomes thinner after standing a short time. It is most conveniently applied with a brush and should be brushed out to a thin coat.

*Volck, California Comm. Hort., Monthly Bul. 6:80—89. 1917.

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